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The Prognostic Value of Kidney Transplant Center Report Cards

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Abstract

SRTR report cards provide the basis for quality measurement of US transplant centers. There is limited data evaluating the *prognostic* value of report cards, informing whether they are predictive of prospective patient outcomes. Using national SRTR data, we simulated report cards and calculated Standardized Mortality Ratios(SMR) for kidney transplant centers over five distinct eras. We ranked centers based on SMR and evaluated outcomes for patients transplanted the year following reports. Recipients transplanted at the 50th, 100th and 200th ranked centers had 18% (AHR=1.18,1.13–1.22), 38%(AHR=1.38,1.28–1.49) and 91%(AHR=1.91,1.64–2.21) increased hazard for one-year mortality relative to recipients at the top-ranked center. Risks were attenuated but remained significant for long-term outcomes. Patients transplanted at centers meeting low-performance criteria in the prior period had 40%(AHR=1.40,1.22–1.68) elevated hazard for one-year mortality in the prospective period. Centers' SMR from the report card was highly predictive(c-statistics>0.77) for prospective center SMRs and there was significant correlation between centers' SMR from the report card period and the year following(ρ=0.57, $p<0.001$). Although results do not mitigate potential biases of report cards for measuring quality, they do indicate strong prognostic value for future outcomes. Findings also highlight that outcomes are associated with center ranking across a continuum rather than solely at performance margins.

Keywords

SRTR; public policy; quality of care; kidney transplantation; transplant centers; patient survival; transplant center volume; reporting quality

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Disclosure

The authors report no conflicts of interest for this study.

Introduction

Report cards for transplant centers are publicly available on a biannual basis published by the Scientific Registry of Transplant Recipients (SRTR). SRTR report cards provide detailed information about recipient and donor characteristics for each US transplant center as well as risk adjusted outcomes (1). In recent years, these report cards have received increased prominence due to the Conditions of Participation issued by the Centers for Medicaid and Medicare Services (CMS) which details an explicit association between public funding of transplant programs with outcomes of SRTR report cards (2). Issues regarding the appropriate development, use and interpretation of report cards are contentious in the transplant community (3). Debates surrounding report cards include understanding the appropriate balance between centers' resource limitations to collect additional data used for risk adjustment and the need to improve the predictive value of models for accurate quality measurement of centers (3;4).

Report cards in healthcare may serve an important role of quality assurance and identification of best practices but have been criticized for lack of appropriate risk adjustment, ineffective dissemination of results to patients and unintended consequences such as limiting care for high risk or vulnerable patients (5–9). In transplantation, the regulatory perspective includes the viewpoint that report cards can be valuable tools for quality improvement initiatives (10–12). SRTR report cards have been shown to influence patient registration at transplant centers suggesting that patients and/or insurance companies utilize report cards for decision-making purposes (13;14). However, there are concerns about the appropriate use and impact of SRTR report cards based on documented biases, poor discriminatory power, the potential to stifle innovation and associations of low performance evaluations with reductions in transplant volume (15–21).

One aspect of transplant center report cards that has not been thoroughly investigated is the reliability of report cards over time. There is an implicit assumption that center outcomes as reflected in SRTR report cards not only describe past performance but are a reasonable proxy for prospective center quality. However, it is not clear if report cards derived over a fixed period are useful indicators of outcomes for prospective patients. If in fact report cards are highly predictive of prospective outcomes, this would suggest that measured center quality is relatively stable and report cards may be used with greater confidence to guide quality initiatives or decision-making tools for patients. In contrast, if there are significant fluctuations in measured quality, decisions or policies based on report cards may be less useful in practice.

In this study, our primary aim was to evaluate the prognostic value of report cards for kidney transplant centers in the United States. We evaluated the degree to which kidney transplant recipient survival was associated with report cards from prior periods and whether this association was consistent for short and long-term outcomes. In addition, we investigated whether the association of report cards with prospective outcomes was consistent for different subgroups of patients, by center volume as well as whether there was an association of recipient outcomes with centers that received prior flags for poor performance. Finally, we evaluated the relationship between centers' standardized mortality

ratios (SMR) for the report card period with the center SMR for the year following the report card.

Methods

This study used data from the Scientific Registry of Transplant Recipients (SRTR). The SRTR data system includes data on all donor, wait-listed candidates, and transplant recipients in the US, submitted by the members of the Organ Procurement and Transplantation Network (OPTN), and has been described elsewhere (reference). The Health Resources and Services Administration (HRSA), U.S. Department of Health and Human Services provides oversight to the activities of the OPTN and SRTR contractors (22). The primary study population consisted of 63,128 adult primary kidney transplant recipients transplanted in five eras (1/1999-12/1999, 7/2001-6/2002, 1/2004-12/2004, 7/2007-6/2008, and 1/2009-12/2009). The eras represented recipients transplanted within one year following public release of Program-Specific Reports (PSR) based on standard SRTR timelines. For example, outcomes for patients transplanted in 1999 were evaluated based on the simulated December, 1998 SRTR report, which included a 2 ½ year cohort of patients transplanted between July, 1995 and December, 1997. We simulated the SRTR report cards methodology for each 2 ½ year cohort and calculated the observed and expected events for each transplant center. As SRTR models for mortality exclude re-transplant recipients, we also excluded these patients from the analyses. Consistent with SRTR methodology, we used adjusted Cox proportional hazard models including factors in the most recent PSR including donor and recipient demographic characteristics, primary cause of end-stage renal disease, recipient body mass index, recipient primary insurance, HLA-mismatching, panel reactive antibody level, waiting time on dialysis, cold ischemia time, donor cause of death, donor history of hypertension and diabetes, pump usage, expanded criteria donor status (in the deceased donor models for the latter six variables) and donor relationship type (for the living donor model only). Although inclusion of some variables has changed over time, we assumed the effect of variables inclusion/exclusion on report card evaluations was minimal. Also consistent with SRTR methodology, we developed models for living and deceased donors separately and combined results of observed and expected events to calculate Standardized Mortality Ratios (SMR). We also generated models for graft loss (defined as the composite event of death, re-transplantation or return to dialysis) as the outcome in which we included re-transplant recipients. For all models, we excluded patients transplanted at centers with less than ten transplants based on current policies for review of small programs and instability of SMR as a performance metric at this volume. To evaluate the effect of report cards on prospective outcomes, we combined recipients over each era. In these models, In order to account for clustering of patients within centers we utilized the robust sandwich estimator for the Cox proportional hazard models to adjust variance estimates accordingly (23).

The primary exposure variable for the statistical models was the center SMR generated from the risk adjusted Cox proportional hazard models for one-year mortality and graft loss. We ranked centers using the SMR for each period and examined patient outcomes relative to the center ranking from the report preceding their transplant date. In order to evaluate whether the effect of center ranking was different by center volume, we stratified models by quartile

of volume and tested the effects in each group. We also tested whether effects of center ranking were consistent by recipient, donor and transplant characteristics. For these models we included an interaction term of the applicable characteristic by center rank and tested the effect of the interaction in the Cox models. Centers were defined as flagged for low performance if they met the three rules currently used by the SRTR which included: a SMR>1.5, observed-expected events>3 and an SMR statistically significantly difference from one based on a Poisson test. We developed logistic models to evaluate the probability that a center would have a SMR exceeding different thresholds the year following the report card based on the SMR in the prior period. In addition, we calculated the correlation (Spearman's) between centers' SMR from the report card period and the year following the report card. All analyses were conducted in SAS (v.9.2, Cary, N.C.).

Results

There were 233 transplant centers in the study population. The distribution of patient characteristics based on quartile of center ranking is displayed in Table 1. Of note, although some comparisons were statistically significant, there were only mild differences in the composition of risk factors between groups. The median SMRs for centers during the report card periods was 0.98 and the 25^{th} and 75^{th} percentiles were equal to 0.69 and 1.23 respectively. Centers were ranked based on ascending SMR and matched with patients transplanted at the same centers the year following the report card.

Center rank had a statistically significant association with prospective recipient outcomes. A difference in rank of 40 was associated with a 14% increased hazard for one-year mortality (AHR=1.14, 95% CI 1.11–1.17) among recipients in the prospective period. Figure 1 depicts the estimated effect of center rank on one-year adjusted mortality for recipients relative to the center ranked 1^{st} in the prior period. As illustrated in the figure, this effect equated to a 38%, 62% and 91% increased mortality hazard associated with the 100^{th}, 150^{th} and 200^{th} ranked center for prospective patients. Based on this model, a difference in center rank of 8 (based on the SMR from the report card) equated to a statistically significantly improved survival for recipients in the prospective period. We tested whether there was a non-linear (quadratic) effect of center rank but found no significant effect. Center rank contributed more to the Likelihood of the Cox model for one year mortality (χ^2=74.4, degrees of freedom[df]=1) than donor age (χ^2=64.3, df=1), recipient race (χ^2=34.6, df=1), recipient primary insurance (χ^2=53.7, df=3), panel reactive antibody level (χ^2=14.9, df=1) and waiting time on dialysis (χ^2=23.2, df=1), but less than recipient age (χ^2=298.2, df=1), donor type (χ^2=181.4, df=1), body mass index (χ^2=110.5, df=1) or primary diagnosis (χ^2=157.6, df=4).

The association of center ranking with long-term mortality was attenuated as compared to the one-year model but remained statistically significant. In this model, a rank difference of 40 centers was associated with a 7% increased hazard (AHR=1.07, 95% C.I. 1.05–1.08). As depicted in Figure 2, this equated to an 18%, 28% and 39% increased adjusted hazard for patients transplanted at centers ranked 100^{th}, 150^{th} and 200^{th} relative to patients transplanted at the top ranked center. We also tested the effect of center rank in each of the five eras separately. For one-year mortality, center rank was significantly associated with prospective

patient outcomes in each era, however the effect was attenuated over time with estimated hazard of center rank (per 40) from earliest to the most recent era as follows: 1.19 (95% C.I. 1.12–1.28), 1.18 (95% C.I. 1.10–1.26), 1.14 (95% C.I. 1.07–1.21), 1.14 (95% C.I. 1.06–1.24) and 1.08 (95% C.I. 1.01–1.16).

Prognostic Value of Report Cards by Center Volume

Tables 2a and 2b display the association of center report cards with prospective recipient outcomes stratified by center volume quartile. As indicated, there was a relatively consistent association of center rank by center volume for the hazards of one-year or long-term graft loss or death. The association of center ranking was consistently higher for one-year graft loss and death as compared to long-term outcomes but these differences were similar between small and large volume centers.

Prognostic Value of Center Rank by Transplant Characteristics

Table 3 displays the association of center rank with the adjusted hazard for one-year and long-term mortality by patient characteristics. As indicated in the table, the association of center rank was consistent across patient characteristics with the exception that the effect of center ranking was significantly higher among publicly-insured patients (AHR=1.16, 95% C.I. 1.12–1.20, per 40 center rank) as compared to privately-insured patients (AHR=1.08, 95% 1.02–1.14, per 40 center rank) for one-year mortality. There were no other statistically significant interactions of center ranking with transplant characteristics including recipient and donor age, recipient gender, PRA status, HLA-mismatching, recipient primary diagnosis or presence of obesity.

Prognostic Value of Center Flagging

Figure 3 displays the association of recipient one-year outcomes with transplantation at centers that met any of the three criteria for SRTR low performance flagging (statistical significance, SMR >1.5 or observed-expected events > 3) in the prior report card period. Thirty and 26% of centers met at least one flagging criterion for one-year mortality and graft loss respectively. Patients transplanted at centers that were flagged for poor performance by one or more criterion had a significant association with higher adjusted rates of one-year outcomes including a 40% increased hazard for one-year death (AHR=1.40, 95% C.I. 1.22–1.68) for patients transplanted at centers that previously met all three flagging criteria. The association with outcomes was relatively similar and not significantly different irrespective of whether centers were identified with one or more criterion. The association of flagging with long-term graft loss and mortality was reduced compared to one-year outcomes but remained significant. Patients transplanted at centers that met one, two and three flagging criteria for graft loss in the prior period had a 10% (AHR=1.10, 95% C.I. 1.06–1.15), 21% (AHR=1.21, 95% C.I. 1.14–1.29) and 21% (AHR=1.21, 95% C.I. 1.14–1.28) adjusted hazard for long-term graft loss and 21% adjusted hazard (AHR=1.21, 95% C.I. 1.13–1.29) for long-term mortality among patients transplanted at centers that previously met all three flagging criteria.

Probability of Transplant Center SMR in the Prospective Period

Among the 226 transplant centers included in the study population that also had at least 10 transplants in the year following the report card, 48% had a SMR>1 (i.e. more observed deaths than expected) in the prior period and 50% had SMR>1 in the prospective period. Among centers with a SMR>1 in the report card period, 73% had a SMR>1 in the prospective period. Similarly, among centers with SMR<1 from the report card period, 72% had an SMR<1 in the prospective period ($p<0.001$). Figure 4 displays the estimated likelihood of a SMR exceeding different thresholds for one-year mortality based on the SMR in the prior period. For example, for a center with a 0.5 SMR from a report card, the estimated probability of a SMR>1 was 20% and a SMR>1.5 4% in the prospective period. For a center with a 2.0 SMR in the report card period, the estimated probability of a SMR>1 was 94% and a SMR>1.5 64% in the prospective period. The concordance indices for each of these models were >0.77 and slightly higher for larger centers. The correlation between the SMRs for one-year mortality for transplant centers from the report card period and the year following the report card was 0.57 ($p<0.001$, Figure 5). The correlation was relatively consistent by center volume but numerically highest among the largest volume centers (quartile 4 centers, $\rho=0.70$).

Discussion

The primary findings of the study are that (1) center ranking based on standardized mortality ratios has strong prognostic value for prospective risk-adjusted recipient outcomes (2) the association of transplant center rank with prospective outcomes is relatively consistent by patient characteristics and center volume and (3) centers which met flagging criteria for poor performance are also significantly associated with diminished risk adjusted outcomes for prospective patients. Importantly, current flagging rules by the SRTR and CMS only identify a small proportion of centers while the association of center ranking with prospective patient outcomes is a continuous effect.

There are several potential interpretations of the results of this study. Primarily, results indicate that the outcomes of SRTR reports for kidney transplant centers are strong indicators of risk adjusted outcomes for the next cohort of transplant recipients. This may reflect that center practices are relatively stable and large deviations in outcomes are not common for most centers. One of the important utilities of these results is to illustrate that center performance is not adequately characterized in a categorical manner (e.g. better or worse than expected). Rather, the association of prior performance with prospective outcomes appears to be relatively linear and observable across the spectrum of measured quality. Furthermore, the magnitude of the relative hazard by center rank is appreciable even within centers that are ‘performing as expected’. For example, differences in recipient outcomes between the 50^{th} and 100^{th} ranked centers are associated with almost a 20% increased hazard and are comparable to differences between the 150^{th} and 200^{th} ranked centers, in which only the latter case would centers have been identified for low performance based on current CMS and SRTR criteria. Findings also demonstrate that centers’ SMRs are highly predictive of prospective SMRs applicable for future reports. Low center performance flags based on current rules also portend relatively high risks for

prospective recipients transplanted in the next year at these centers. Interestingly, however, the additive prognostic value of each of the flagging criterion was minimal as the risks were similar whether centers met one or all three of these criteria. Cumulatively, these findings suggest that measured performance is unlikely to change in a short duration and is a relatively reliable indicator of outcomes for prospective recipients.

One of the unexpected findings of the study was that the relationship between report cards and prospective outcomes was relatively consistent by center volume. Both intuitively and mathematically, it may have been expected that outcomes from larger centers (with smaller variability of estimated performance) would be more reliable indicators of prospective outcomes. However, findings from the study indicate that risk adjusted outcomes (i.e. SMRs and center ranking) are consistently associated with patient outcomes for both small and larger centers and the predictive value of report cards is only slightly larger for the highest volume centers. Although wide variations in SMRs might be more expectable for small centers, the findings suggest that even for small and moderate volume centers, report cards have significant prognostic value. Another interesting result was that, while the prognostic value of report cards was significant for each of the eras evaluated, the effect appeared to decline over time. It is possible that this reflects more attention to report cards by centers due to enhanced regulatory oversight and more rapid response to results of report cards (reflected by the reduced effect of prior center ranking). However, this will need to be confirmed in future studies, particularly with greater follow up time since the issue of the Conditions of Participation by CMS.

The primary findings of the study were also relatively consistent by recipient and characteristics. This suggests that, independent of patient acuity and demographic characteristics, center performance has a relatively similar prognostic value applicable to all patient groups. One might expect that center quality has more of an impact in certain patient groups or donor types, but the findings indicate a fairly robust association for all transplant types. The exception in this study was a discordant effect of center ranking on patients based on their primary source of insurance. Specifically, the effect was more pronounced among patients with public insurance. This could suggest the publicly insured patients are more highly affected by center quality as compared to privately insured patients and factors that explain short-term mortality are different in these groups, however, the effect was not significant for long-term mortality and the source of differences in one-year mortality are speculative and cannot be clearly defined in this study.

Results of the study have important implications for decision-making among policy makers, transplant centers and patients and caregivers. From a policy perspective, findings suggest that transplant center report cards are a relatively reliable indicator for purposes of quality assurance and improvement efforts. This includes interpretation of metrics in order to identify centers with lower performance as well as centers of excellence (i.e. those with higher performance). Findings suggest that regulators may have some assurance that outcomes summarized by report cards are relatively stable on average and policies for identifying poor or exceptional centers are important for prospective patients. The findings may also suggest that quality improvement efforts may take significant time to translate into improved measured outcomes. From a transplant center perspective, findings also indicate

that, on average, risk adjusted outcomes are consistent over time and provide a relatively stable indicator of measured performance. This may be important for administrative purposes and contract negotiations with private insurance companies as well as identifying opportunities to utilize data from report cards to improve care. It should be noted that prospective report cards (i.e. subsequent series of SRTR report cards) are likely even more stable than the results in the present study given that they include an overlapping cohort of patients. Thus, from a centers' perspective, understanding the source of risk adjusted outcomes (either positive or negative) is important and notable alterations in outcomes may require significant changes in both practice and time. From a patient perspective, results suggest that report cards may be a useful indicator of prospective results and a reliable tool to incorporate in decision-making including center selection. In fact, prior studies have indicated that center characteristics can have a substantial impact on long-term patient prognoses and the present findings validate that selecting centers based on prior outcomes is an important consideration (24–27). Results also validate processes to convey prior outcomes to prospective patients and enhance transparency and facilitate decision-making. Figure 4 illustrates the probability of centers' prospective SMR to fall in select ranges given a SMR from the report card period. By drawing a vertical line from the SMR on the x-axis, one can estimate the likelihood that a center would have a prospective SMR in the given ranges. It is notable, that large departures in centers' SMRs are not common but also suggest some degree of regression to the mean as centers with low and high SMRs do tend to have lower probability of remaining in the extreme ranges.

Despite the relatively strong prognostic value of report cards, it is also important to emphasize that the results of this study do not mitigate potential biases with respect to measuring quality of care of transplant centers. An important distinction for the interpretation of the findings of this study is that while report cards do appear to be highly predictive of prospective risk-adjusted survival, the findings do not provide any evidence as to the accuracy or precision of report cards with actual quality of care. In fact, there have been a number of studies documenting factors that may be systematically different between transplant centers that are not accounted for in SRTR report cards that can impact accurate measures of quality (18;28–31). In addition, the predictive value of models used to generate report cards (concordance indices ranging from 0.61–0.68) is relatively low suggesting other factors may be related to risk adjusted outcomes besides those factors that are accounted for in models (32;33). Thus, even though results of report cards are prognostic for adjusted outcomes and measurement of center quality, the same underlying biases that can affect the report card could be salient in the prospective period pertinent to this study. Transplant centers that have a relatively high presence of underlying (unadjusted) risk factors may continuously be ranked lower in any of the risk adjusted analyses irrespective of their true quality of care. The results should also be placed in the context that posttransplant risk adjusted outcomes may not be the most important factor for candidates selecting a transplant center. In fact, a prior study demonstrated that median waiting time had the most pronounced association with candidate survival among center characteristics including post-transplant survival (25). Finally, we did not investigate the prognostic value of report cards over longer durations (that may be salient to candidates who are not expected to receive a transplant for several years). For patients with extended waiting times, the association of

report cards years before their transplant may be less important and future studies examining the durability of report cards over time may be important to investigate to help guide decision-making. In addition, from a regulatory perspective, these data do not necessarily suggest that programs with poor outcomes are destined to produce lower risk adjusted outcomes over an extended period, but it is likely that changes in performance that do occur will require sufficient follow up time.

In summary, the primary finding of our study is that risk adjusted outcomes used for kidney transplant center report cards have strong prognostic value for prospective recipient outcomes. Report cards may be viewed as reliable indicators of outcomes for patients transplanted at centers in the following year and this association is relatively consistent by center volume and patient characteristics. These results have implications for the interpretation of report cards for policy makers, transplant centers and patients but should also be viewed in the context that results do not obviate sources of bias for measured performance. Continued efforts for utilizing report cards to identify best care practices among centers and to provide transparent information to patients and caregivers are critically important.

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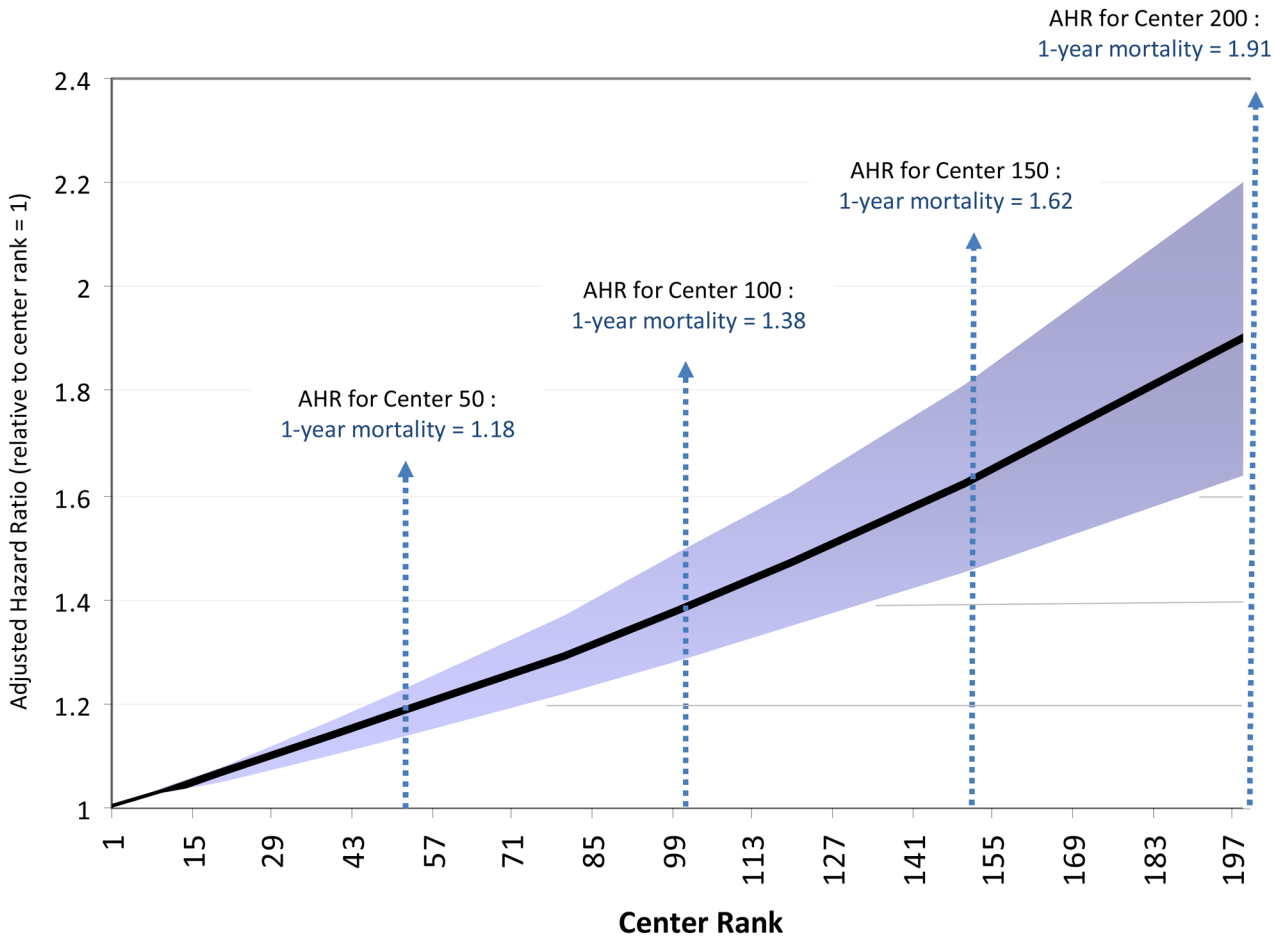


Figure 1.
Adjusted Hazard for One-Year Mortality based on Center Rank in Prior Report Card Period

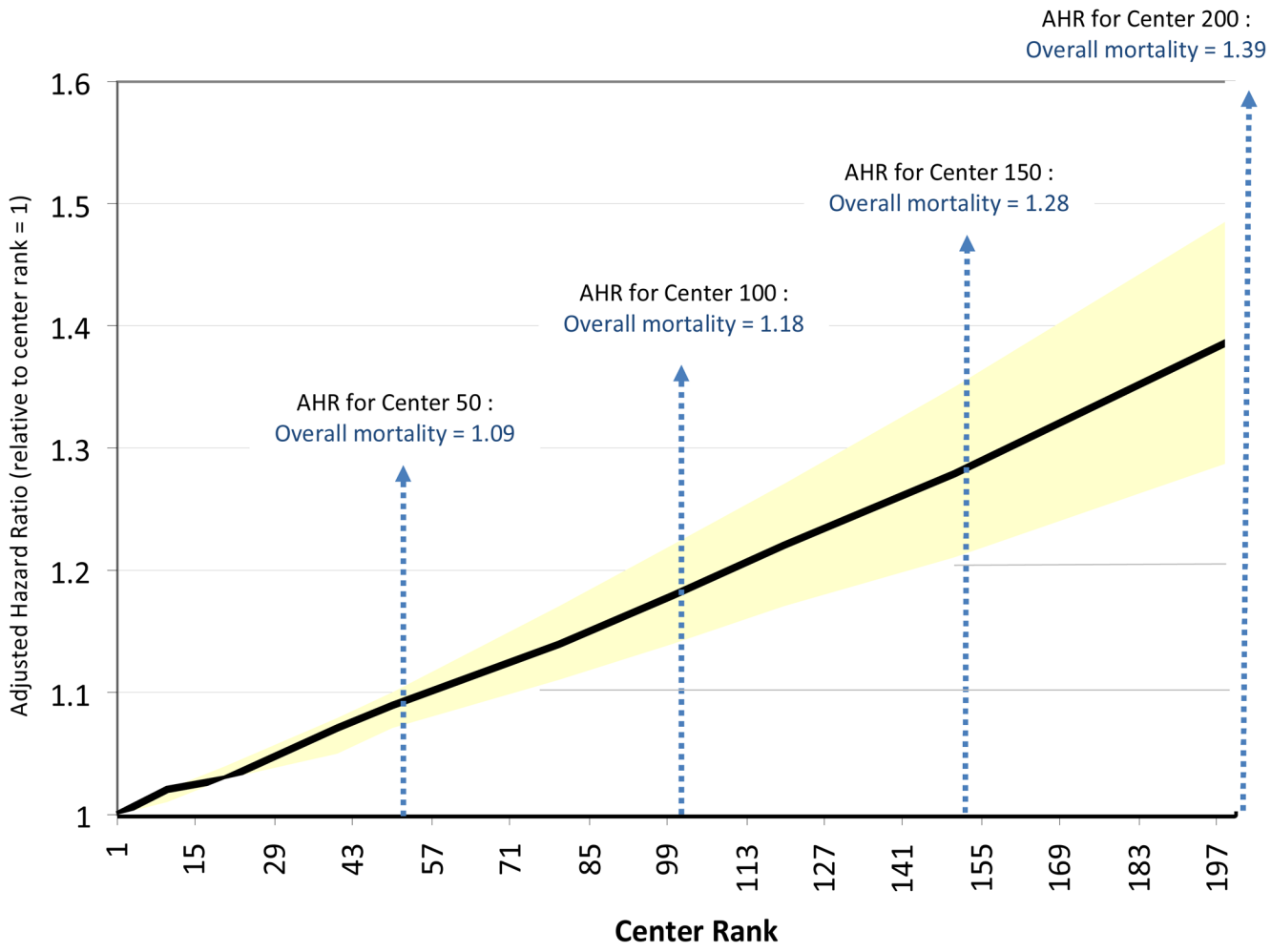


Figure 2.
Adjusted Hazard for Long-Term Mortality based on Center Rank in Prior Report Card Period

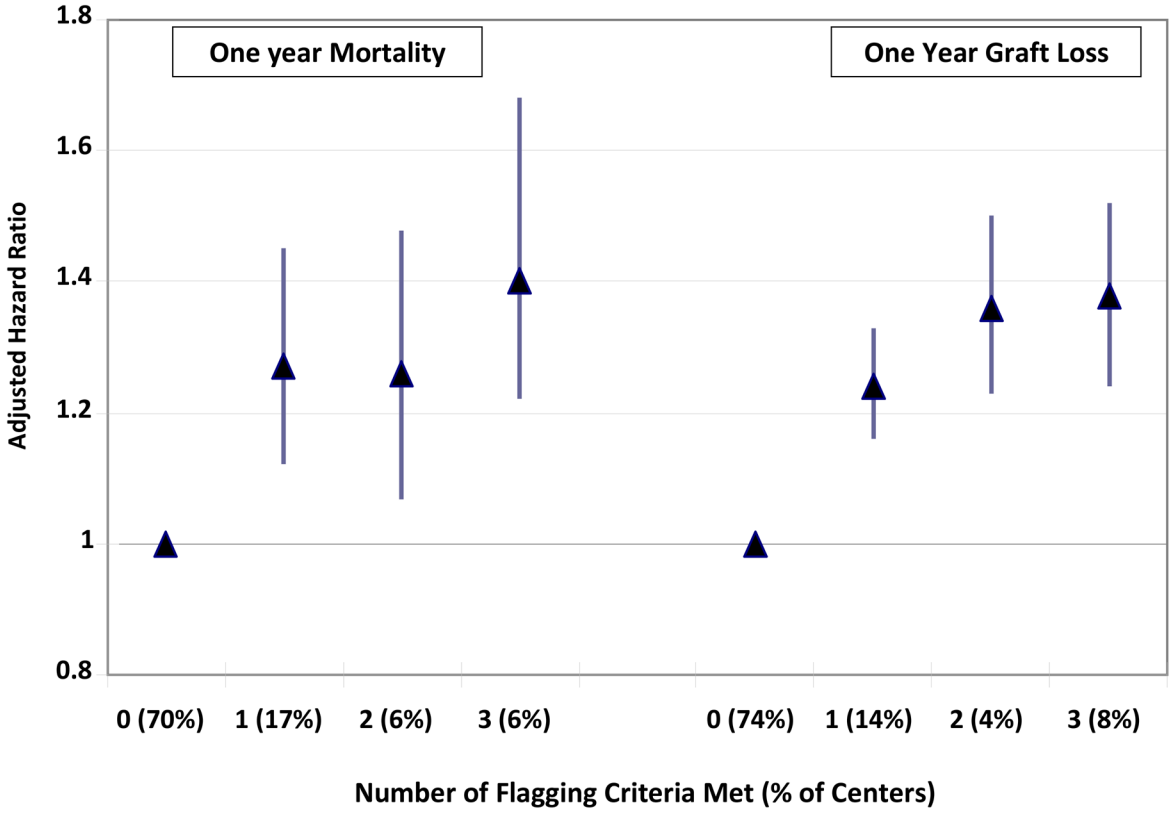
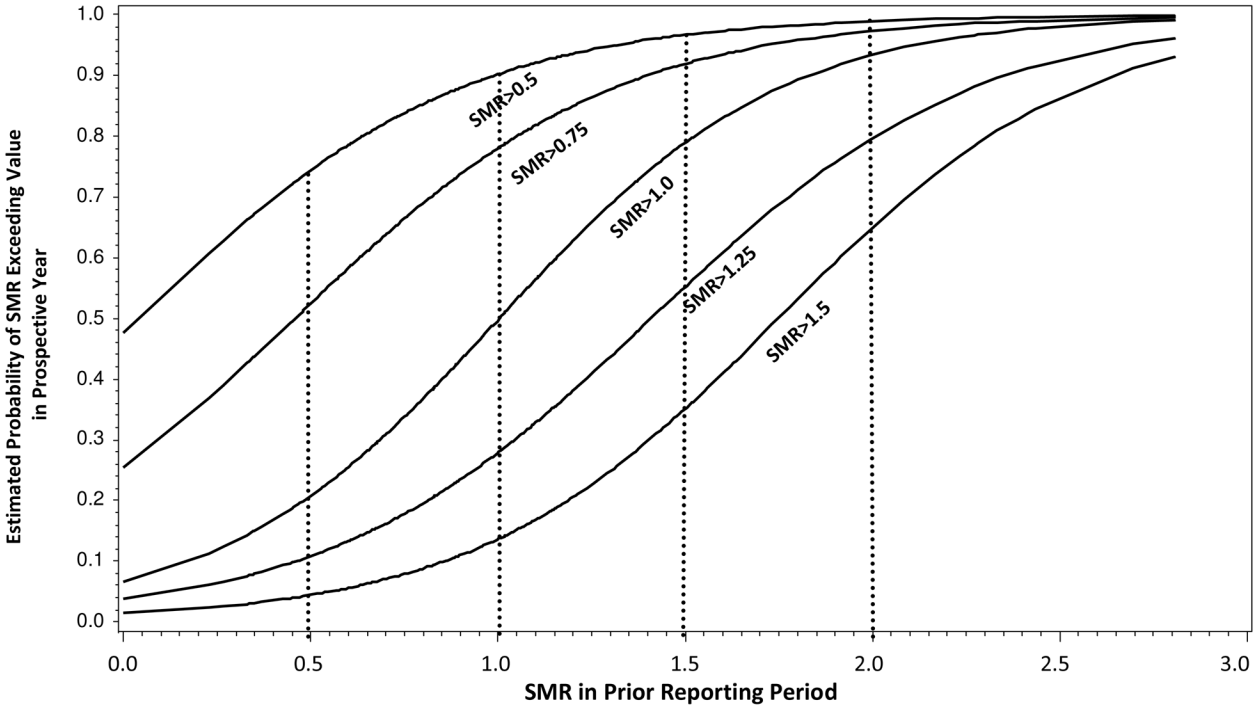


Figure 3. Association of Prior Performance Flagging Criteria on Prospective Outcomes*

* Criteria include statistically significantly worse than expected (one-sided p-value <0.05), observed-expected events > 3, observed/expected ratio > 1.5; models adjusted for recipient and donor age, gender, race, recipient primary diagnosis, donor type (living or deceased), functional status, re-transplantation (for graft loss model only), human leukocyte antigen mismatching, recipient panel reactive antibody status, waiting time on dialysis, recipient body mass index and recipient primary insurance.



SMR in prior reporting period	Probability of SMR exceeding value in prospective year				
	0.5	0.75	1.0	1.25	1.5
0.5	74%	51%	20%	10%	4%
1.0	90%	78%	50%	28%	14%
1.5	97%	92%	79%	55%	34%
2.0	99%	97%	94%	79%	64%

Figure 4. Probability of Prospective SMRs for Transplant Centers based on SMR from Prior Reporting Period

* concordance indices for models evaluating likelihood of center SMR> 0.5, 0.75, 1.0, 1.25 and 1.5 were 0.77, 0.77, 0.78, 0.80, 0.81 respectively

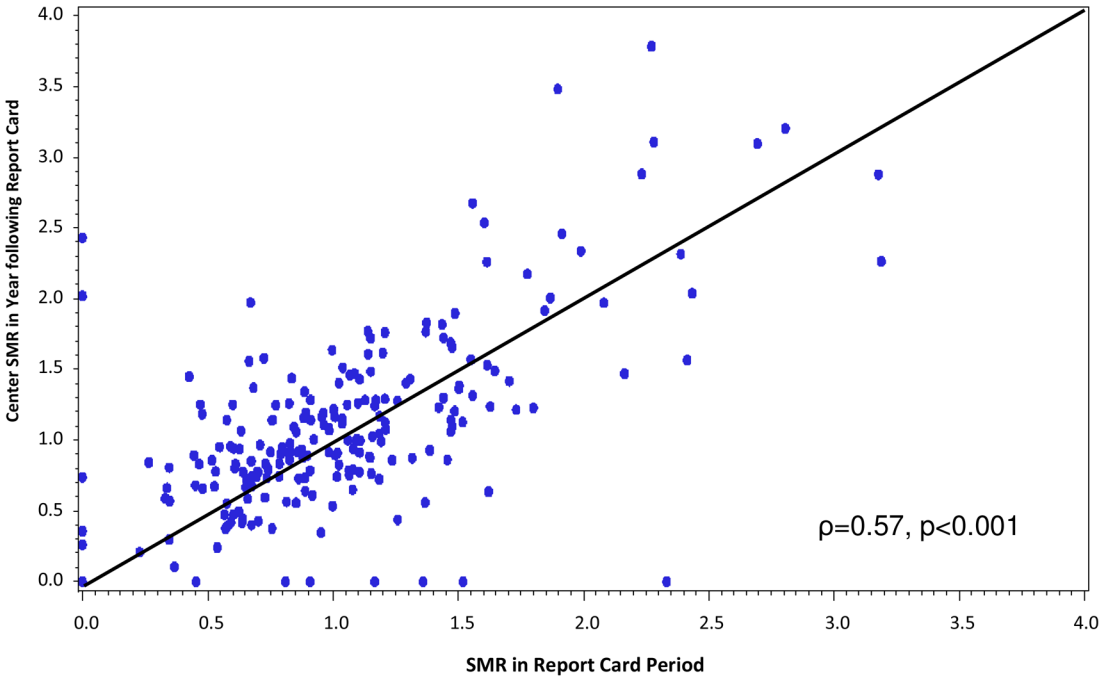


Figure 5. Correlation between Transplant Center Standardized Mortality Ratios for Report Card and Year following Report Card

note: 4 observations out of range not displayed in graph

Table 1

Transplant Characteristics by Center Rank (n=63,128)*

Transplant Characteristics	Center Rank (based on model for One-year mortality)				
	Top Quartile (1st–25th percentile)	Second Quartile (26th–50th percentile)	Third Quartile (51st–75th percentile)	Fourth Quartile (76th– 100th percentile)	pvalue*
Recipient age (mean ±sd)	49.7 ± 13.3	49.7 ± 13.4	50.0 ± 13.5	49.7 ± 13.2	0.07
Donor age (mean ± sd)	39.0 ± 15.0	39.3 ± 14.9	40.0 ± 15.3	38.8 ± 15.1	<0.001
Diabetes as primary diagnosis (%)	23%	24%	24%	25%	0.04
Females (%)	40%	40%	40%	39%	0.74
Deceased donor (%)	63%	60%	62%	61%	0.11
PRA=0% (%)	54%	51%	54%	50%	<0.001
Pre-transplant dialysis time >=36 months (%)	28%	30%	29%	30%	<0.001
Obese (%)	29%	29%	30%	31%	0.002
Private Primary Insurance (%)	43%	40%	45%	40%	0.002
Six-antigen HLA match (%)	12%	11%	11%	11%	0.003

* includes patients transplanted the year following release of the center report card

Table 2a

Association of Prior Center SMR on Prognostic Risk for Graft Loss Stratified by Center Volume

Center Volume (from prior report card cohort)	Adjusted Hazard Ratio associated with Center Rank (per 40) in Prior Reporting Period **	
	One-year Graft Loss (95% C.I.)	Long-Term Graft Loss (95% C.I.)
10–129	1.10 (1.06 – 1.14)	1.05 (1.03 – 1.07)
130–211	1.13 (1.09 – 1.17)	1.04 (1.02 – 1.06)
212–352	1.10 (1.05 – 1.15)	1.07 (1.05 – 1.10)
353–820	1.13 (1.09 – 1.18)	1.09 (1.06 – 1.12)

* Center Rank based on SMR for Graft Loss in period prior to transplant

** Models adjusted for recipient and donor age, gender, race, recipient primary diagnosis, donor type (living or deceased), functional status, re-transplantation, human leukocyte antigen mismatching, recipient panel reactive antibody status, waiting time on dialysis, recipient body mass index and recipient primary insurance.

Table 2b

Association of Prior Center SMR on Prognostic Risk for Patient Death Stratified by Center Volume

Center Volume (from prior report card cohort)	Adjusted Hazard Ratio associated with Center Rank (per 40) in Prior Reporting Period **	
	One-year Death (95% C.I.)	Long-Term Death (95% C.I.)
10–129	1.14 (1.09 – 1.19)	1.06 (1.04 – 1.08)
130–211	1.15 (1.08 – 1.23)	1.07 (1.04 – 1.11)
212–352	1.14 (1.07 – 1.22)	1.08 (1.05 – 1.12)
353–820	1.12 (1.04 – 1.20)	1.08 (1.05 – 1.12)

* Center Rank based on SMR for Death in period prior to transplant

** Models adjusted for recipient and donor age, gender, race, recipient primary diagnosis, donor type (living or deceased), functional status, human leukocyte antigen mismatching, recipient panel reactive antibody status, waiting time on dialysis, recipient body mass index and recipient primary insurance.

Table 3

Association of Center Ranking on Post-transplant Outcomes by Transplant Characteristics

Transplant Characteristics	Adjusted Hazard Ratio associated with Center Rank (per 40) in Prior Reporting Period*	
	One-year Mortality (95% C.I.)	Long-Term Patient Mortality (95% C.I.)
All patients	**1.14 (1.11–1.17)**	**1.07 (1.05 – 1.08)**
Recipients >= 60 years	1.17 (1.12 – 1.22)	1.07 (1.05 – 1.10)
Recipients 18–59 years	1.12 (1.07 – 1.16)	1.06 (1.04 – 1.08)
Recipient BMI >= 30 kg/m^2	1.11 (1.06 – 1.18)†	1.07 (1.04 – 1.10) †
Recipients BMI < 30 kg/m^2	1.14 (1.09 – 1.18)	1.07 (1.05 – 1.09)
Private Pay Recipients	1.08 (1.02 – 1.14)**	1.05 (1.02 – 1.07)
Non-Private Pay Recipients	1.16 (1.12 – 1.20)	1.08 (1.06 – 1.09)
Deceased Donor Recipients	1.15 (1.12 – 1.19)	1.08 (1.06 – 1.09)
Living Donor Recipients	1.08 (1.01 – 1.15)	1.05 (1.02 – 1.07)
Donor Age >= 60 years	1.07 (0.99 – 1.16)	1.05 (1.01 – 1.09)
Donor Age < 60 years	1.15 (1.11 – 1.19)	1.07 (1.06 – 1.09)
Recipients with Diabetes as PDGN	1.15 (1.10 – 1.20)	1.07 (1.04 – 1.09)
Recipients without Diabetes as PDGN	1.13 (1.09 – 1.18)	1.07 (1.05 – 1.09)
African American Recipients	1.15 (1.09 – 1.22)	1.06 (1.03 – 1.09)
Non-African American Recipients	1.13 (1.09 – 1.17)	1.07 (1.05 – 1.09)
PRA > 0%	1.17 (1.12 – 1.22)	1.07 (1.05 – 1.09)
PRA = 0%	1.10 (1.06 – 1.15)	1.07 (1.04 – 1.09)
Males	1.13 (1.09 – 1.17)	1.08 (1.06 – 1.09)
Females	1.15 (1.09 – 1.21)	1.06 (1.03 – 1.08)

* Center Rank based on SMR for one-year mortality in period prior to transplant; models adjusted for recipient and donor age, gender, race, recipient primary diagnosis, donor type (living or deceased), functional status, retransplantation, human leukocyte antigen mismatching, recipient panel reactive antibody status, waiting time on dialysis, recipient body mass index and recipient primary insurance.

** $p<0.05$

† Models exclude patients with missing values